
Space Weather Technical Forecast

Issued on Tuesday, 14 March 2023 at 13:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of Minor Geomagnetic storms due to possible glancing CMEs and CH84 enhancement on day 2 (15th). S1/Minor Radiation storm from far-sided eruption continuing at times.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with only isolated C-flares observed, peaking C3.1 at 14/0605 UTC. There are ten sunspot regions currently on the Earth-facing disc. These are a mixture of small, mature spots with a few small but emergent/developing regions. Some slight growth has been observed in the yet unnumbered regions, though no single spot appears show any significant growth or magnetic attributes.

No sig CME's have been observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind observed at L1, has been indicative of a glancing transient or weak coronal hole fast wind arrival, with speed increasing from 320km/s to 440 km/s, starting around 14/0400 UTC. The density has been above average throughout, with a peak of 25ppcc at 14/0700 UTC. The total IMF strength was weak to moderate with a notable increase around 14/0350 UTC to 14nT. The north-south component was mainly positive, before becoming more variable from around 14/0300 UTC, fluctuating between +13/-10nT. The Phi angle was mostly positive (away from the Sun) until 14/0945 UTC when it became negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 0-3) with one Active period (Kp 4) between 0300-0600 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16, has been at elevated levels and sometimes above the S1/Minor Storm threshold in response to the large far sided CME from 13th. The high energy electron flux (greater than 2MeV) has been at moderate to background levels. The associated 24 hour Electron fluence has remained below Active. At 14/0000UTC the observed fluence was 1.07e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is generally expected to be Low or Very Low, with isolated C-class flares.

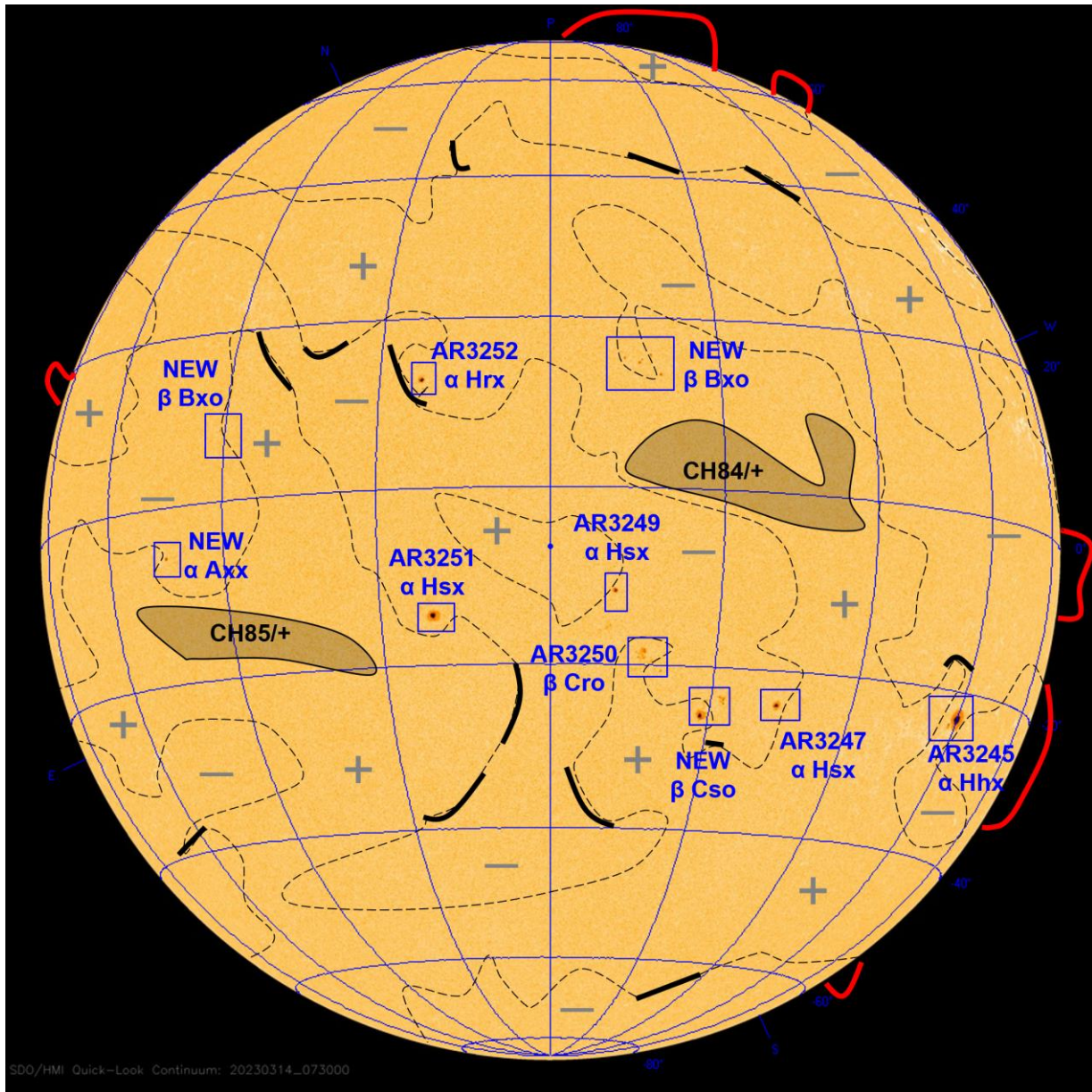
Solar Wind / Geomagnetic Activity: Glancing CME impacts are possible 14 March and through 15 March, due to three filament eruptions that occurred 10-13 March. These are all low confidence, however any combined effect could give a larger geomagnetic response than normally expected from such glancing impacts. Otherwise, an average of slightly elevated solar winds expected through much of the period, with a chance of becoming elevated due to the fast winds from CH84/+ early in the period. Quiet to Unsettled geomagnetic activity is expected, with possible Active intervals. The arrival of any CMEs will likely bring Active intervals with a chance of G1 Minor Storm intervals from late 14 March until 16 March, before easing to mainly Quiet by 17 March.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux, as observed by GOES16, is currently at S1/Minor Storm levels, but expected to gradually decline to

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moderate or background levels. The high energy electron flux is expected to persist at Background to Moderate levels, with fast winds from CH84/+ or any CME likely to continue suppressing flux. Flux levels are likely to rise to Moderate by the end of the period. The associated 24 hour electron fluence is expected to persist at below the Active level, likely declining initially.

Figure 1. Solar Analysis Valid 14/0800 UTC.



Key: Filament ___, Prominence ___, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-γ-δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are a number of CME arrivals, however all are low confidence. The first, from a filament eruption off the southwest quadrant on 10 March may pass close enough to Earth to give some glancing influence late on day 1 (14 March) into day 2 (15 March). A further filament eruption from the southeast disc on 12 March may then glance Earth late on day 2. A faster filament eruption off the northwest disc later on the 12 March is also expected to pass largely north and ahead of Earth, however this too may give a glancing impact during 15 March, perhaps arriving earlier in the day.

Confidence in the impacts from these events is low, however given the number of CMEs potentially arriving in a period of 24-36 hours cumulative impacts may result in a stronger geomagnetic response than would normally be expected for such events.

Furthermore, the fast wind from CH84/+ may bring increased wind speeds to elevated, though this is not favoured for a strong connection around the March equinox due to the Russell McPherron effect. It may however aid increased activity levels given any CME arrival. Any fast wind and CME influence is expected to gradually recede later day 3 and 4 (16-17 March).

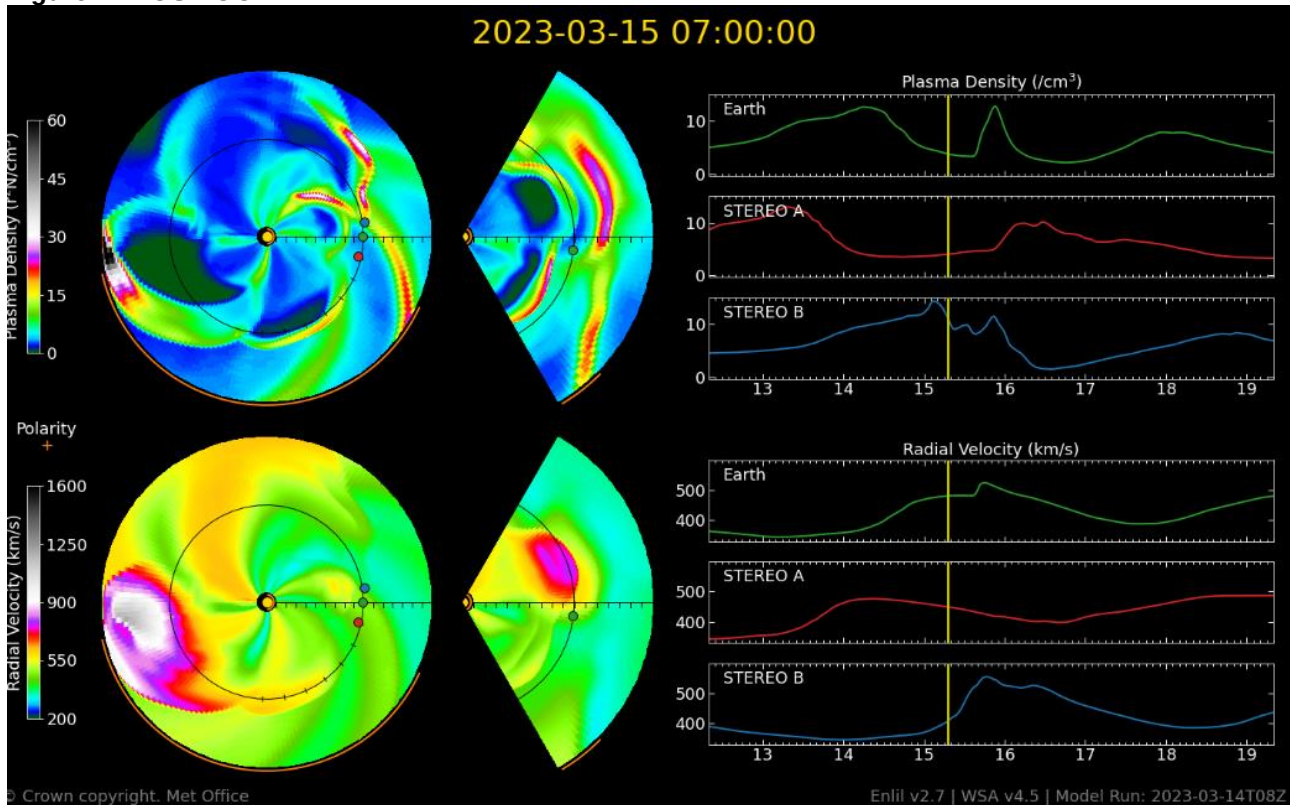
Quiet to Unsettled geomagnetic activity is expected, with possible Active intervals. The arrival of any CMEs will likely bring Active intervals with a chance of G1 Minor Storm intervals from late 14 March until 16 March, before easing to mainly Quiet by 17 March.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	40	30	1
Strong	G3	No	1	2	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0102	Partial	Filament	SW	495 km/s	Missing	Glance possible late 14 th /early 15 th
12/2340	Partial	Filament	SE	760 km/s	15/1800 +/- 6 hrs	Glancing impact
13/1319	Partial	Filament	N	1330 km/s	15/1200 +/- 9 hrs	Likely passing over Earth, but chance of glancing.

Figure 2: MOSWOC ENLIL



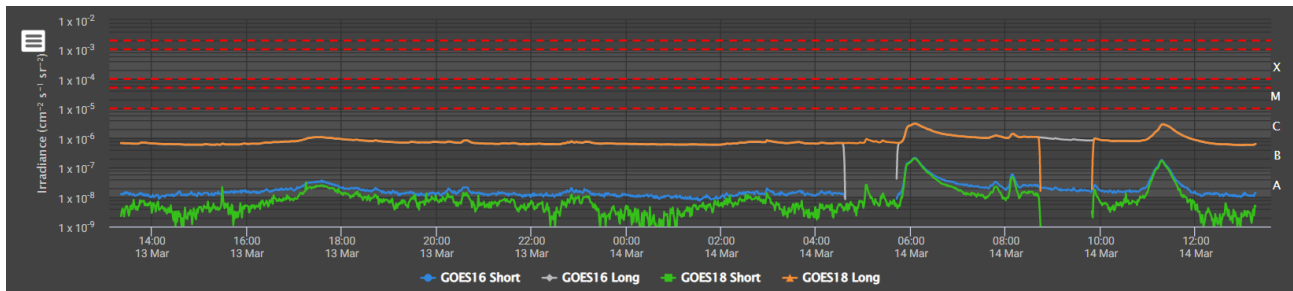
Radio Blackouts - X-Ray Flares:

Solar activity is likely to be Low or Very Low, with isolated C-class flares considered likely. There are several filaments on the disk, should any erupt, they could be another source of C-class flares. There are ten sunspot regions currently on the Earth-facing disc. These are a mixture of small, mature spots with a few small but emergent/developing regions. Some slight growth has been observed in the yet unnumbered regions, though no single spot appears show any significant growth or magnetic attributes.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: 24 hour X-Ray trace

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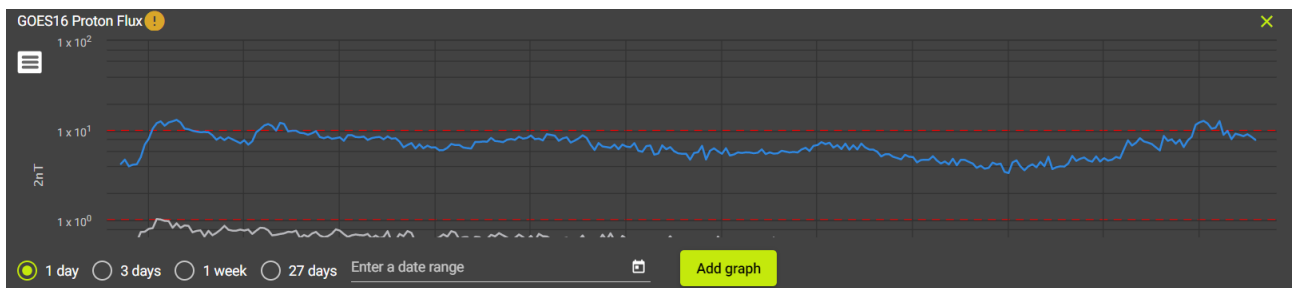
Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux has at times been enhanced through the 13th, due to the significant far-sided event which produced a very fast far-sided CME. Despite its location almost directly opposite Earth, proton flux responded and reached the S1/Minor Radiation Storm threshold several times and most recently since 14/1155UTC. A gradual decline in values back towards background is expected through the period. Given the simplicity of the sunspots currently on the disc, no further enhancements are expected, unless similar far-sided eruptions occur.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	Yes	100	10	1	1
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

Figure 4: GOES 16 Proton flux past 24 hours



High Energy Electrons Event ($\geq 2\text{MeV}$):

The high energy (greater than 2 MeV) electron flux at GEO, as observed by GOES-16, is expected to persist at Background to Moderate levels, with fast winds from CH84/+ or any CME likely to continue suppressing flux. Flux levels are likely to rise to Moderate by the end of the period.

The associated 24 hour electron fluence is expected persist at below the Active level, likely declining initially. REFM is currently giving good guidance on expected conditions.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	5	10
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM integrated flux/fluence.

